A "Listener/Viewer" for Phonocardiograms

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In 1987, Bergeron and Greenes[1] presented a program called HeartLab which allowed users to listen to prerecorded heart sounds in order to build their clinical skills. Inspired by some of the innovations from HeartLab, we present a Macintosh program which allows previously and simultaneously recorded heart sounds and single lead electrocardiogram (phonocardiogram) to be viewed on the screen and played back through the audio output circuitry of any Macintosh computer running System Software Version 7.1. The system currently uses data acquired with a commercially available hardware/software system from BIOPAC Systems, Inc. (Goleta, CA). The software system is AcqKnowledge™ Version 3.0. Other forms of acquisition could also be used as long as the file standards are followed.

The data acquired from the analog signal (AcqKnowledge) files are stored in a BIOPAC proprietary format, but with the aid of BIOPAC Systems, we transformed these files into standard AIFF files for playback of the sounds. The viewer reads the original acquired data and presents it to the user in a "strip-chart" window (see Figure 1). The viewer allows the user to scale the data at varying degrees of resolution in terms of amplitude and time. The amplitude can be increased or decreased to fit the user's needs, as can the time base which can be contracted or expanded at will. Standard scroll bars allow the user to scroll through the entire waveforms.

The system was written using THINK C for the Macintosh and the THINK Class Library, an object-oriented application framework package that defines a generic Macintosh application (Symantec Corp., Cupertino, CA).

In order to keep the size of the data files manageable we sampled the analog data at 2 KHz. A simple low-pass filter is connected to the sound output port when the heart sounds are played back in order to filter out switching transients and their accompanying noise. A high-quality stereo headset are speaker is attached to the filter output in order to listen to the sounds.

The digital phonocardiogram files can be transmitted over any digital network connection and stored along with other patient data. The sonic data can thus be used to document patient encounters, be sent for consultation, and analyzed with various forms of sound spectral analytic tools. In addition, respiratory or gastrointestinal sounds could also be captured for storage and transmission.

Using an object-oriented development approach facilitates future extensions and modifications of the program. In addition, the OOP approach allows much easier code reusability for other type of graphic applications.

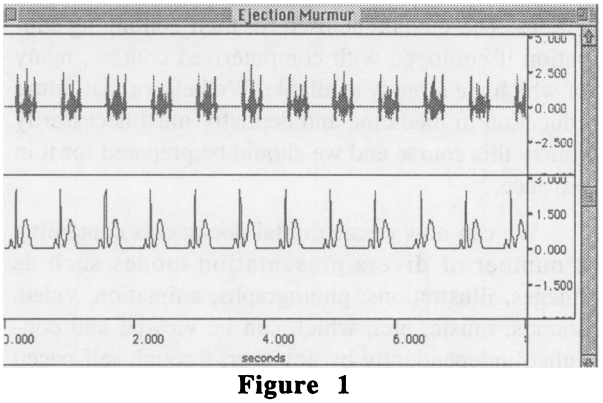

Figure 1

A copy of the strip chart display presented to the users. The sounds are the upper channel and the ECG is the lower channel. Each wave form can be vertically scaled independently and they may be time scaled concurrently. This particular sound is a systolic ejection murmur commonly heard in pulmonic or aortic stenosis.

1. Bergeron, B.P. and R. A. Greenes: "HeartLab and EKGLab:Skill-Building Simulations in Cardiology." Demonstration Digest- Proc.,11th Annual SCAMC. Nov. 1-4, 1987. pp 29-30.

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